ASTRO-STEM ACTIVITIES

Erasmus + 2020-1-TR01-KA229-094247

Under The Same Sky

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1) Introduction

This booklet was prepared to provide information for highschool students and teachers who are interested in Astro-stem.This book was prepared with the information that was obtained as a result of Astro-stem activities and trainings of the astronomy -themed project named Erasmus + Under the same sky. Under the same sky project partnership was caried out betwen Eczacı Bahattin Sevinç Erdinç Fen Lisesi (Türkiye), Itis Ettore Majorana (Italy), Colegiul Tehnic Edmond Nicolau Focsani (Romania), Akademickie Liceum Ogolnokształcace Politechniki Slaskiej Gliwicach (Poland) schools. The project started in December 2020 and ended in December 2023. You can use and share this booklet with peace of mind.

2) What is an Astro-stem activity ?

It is a project that brings together the disciplines of astronomy and stem. Learning environments are created by supporting astronomy gains with stem skills. The project was also used as training material for Sky, stars , planets, asteroids with an innovative approach in education.

3) WHAT IS PARALLAX ?

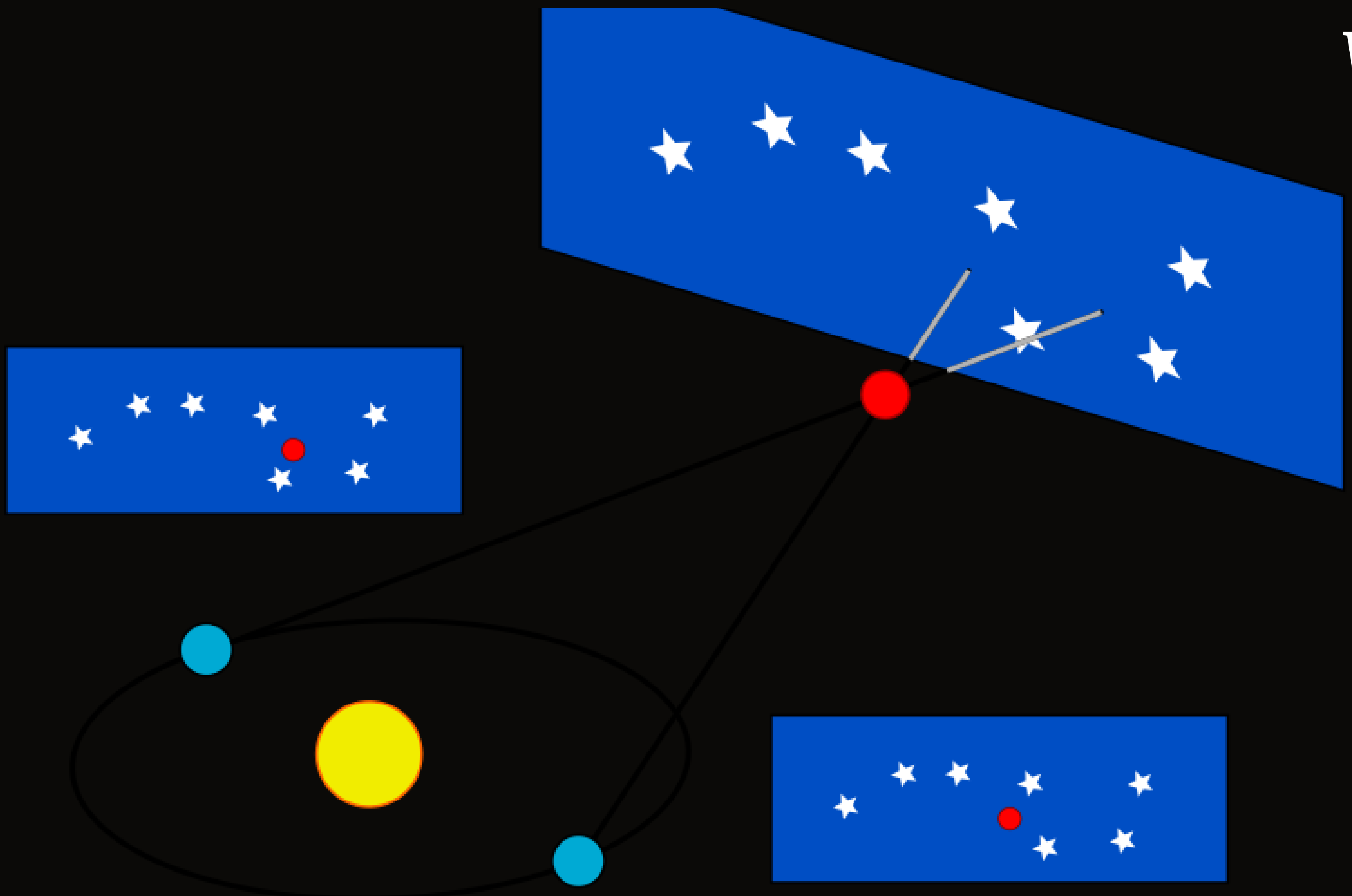
Parallax is the observed displacement of an object caused by the change the observer's point of view.

In astronomy, it is an irreplaceable tool for calculating distances of far away stars.

It is one of the most important distance measurement methods used by astronomers.

4)How do astronomers use parallax?

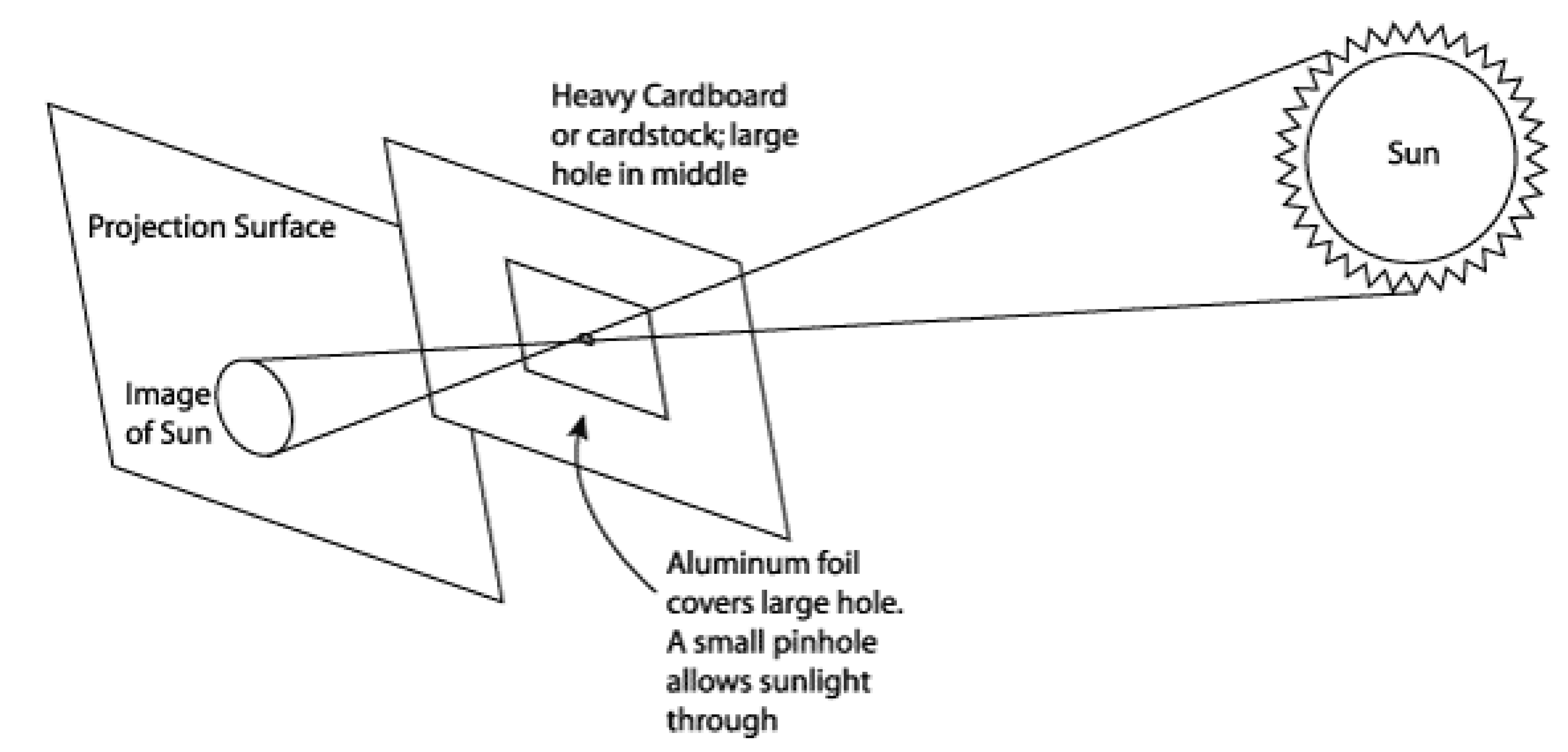
It can only be used for nearby stars, but it is very accurate.
The method works by measuring how nearby object appears to move against the background of more distant objects.



You can try this yourself by looking at a nearby lamppost against a building in the background. When you move position the distance between the lamppost and the background building changes.

You can also see this effect by stretching out your arm whilst holding a pencil. If you close one eye and move your head from side to side. See how the pencil appears to move against wall behind it.

5)MEASURING THE SIZE OF THE SUN WITH A PINHOLE CAMERA

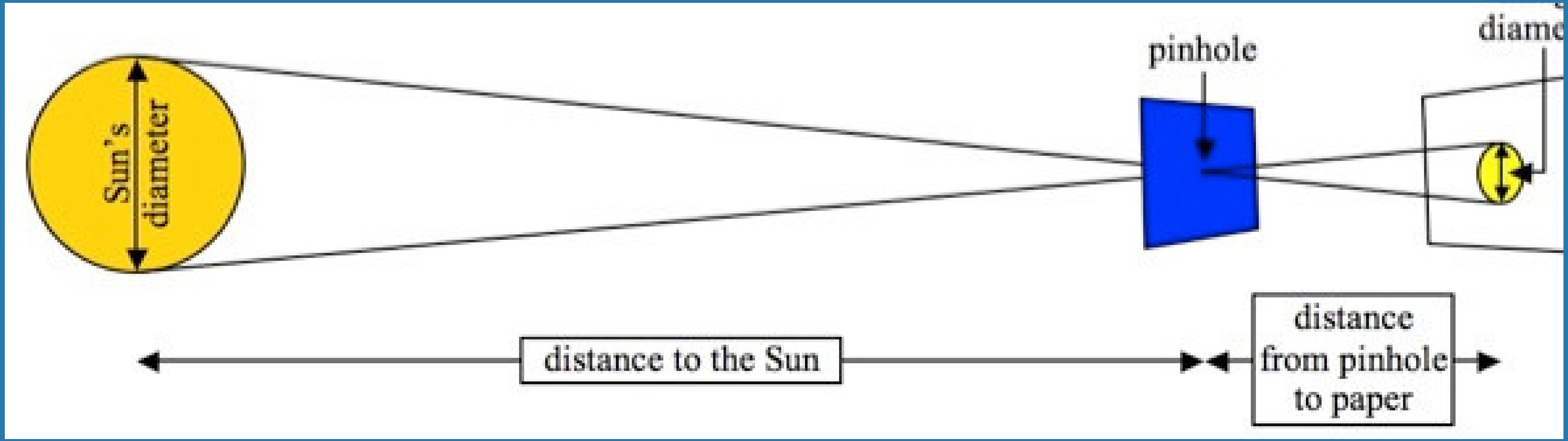


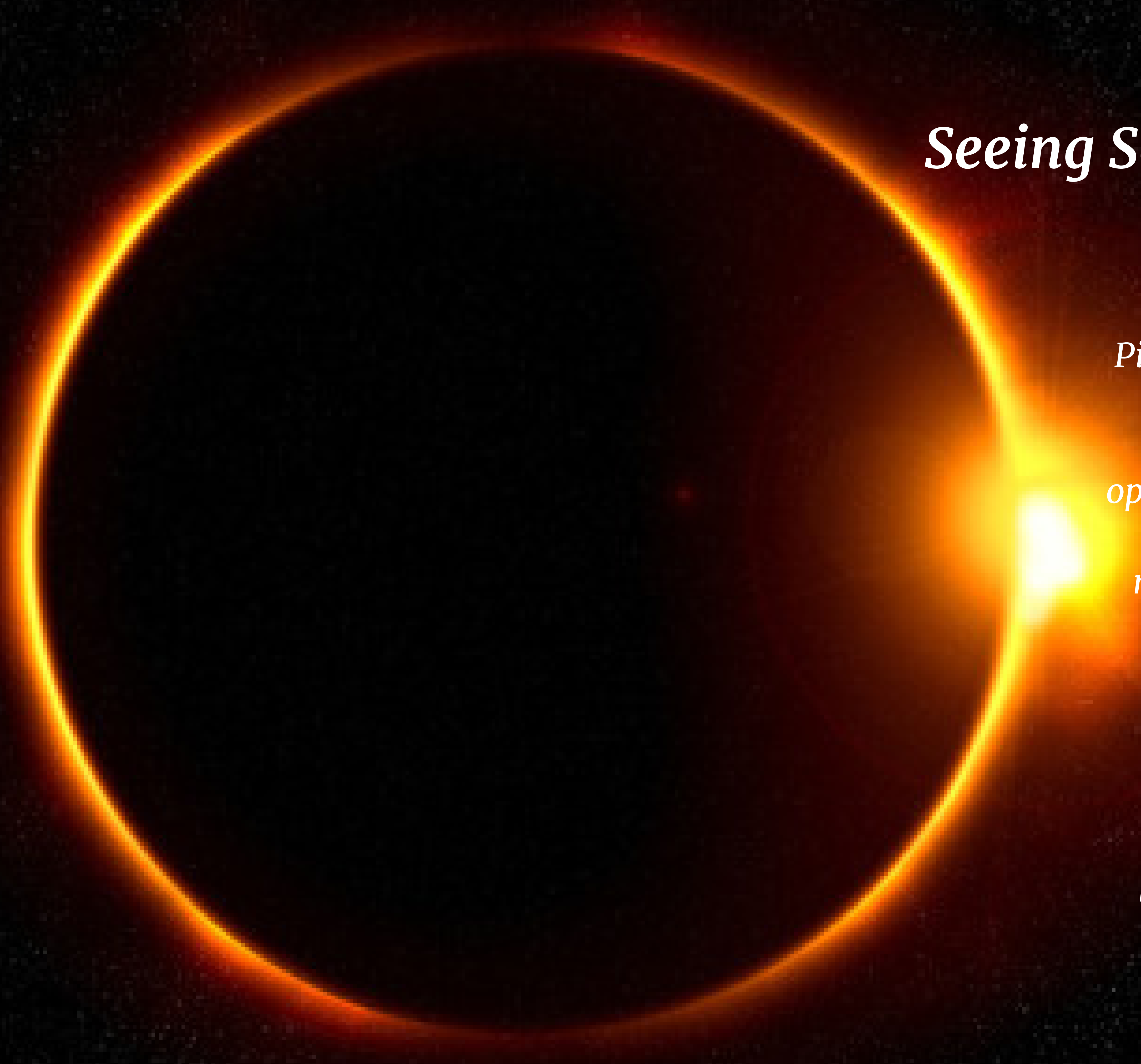
$$\frac{\text{Diameter of Sun}}{\text{Distance to Sun}} = \frac{\text{Diameter of image}}{\text{Distance to image}}$$

6) *STEPS OF OBSERVING*

- *Firstly, you'll stand facing away from the Sun.*
- *Then, you'll lift the viewer hole to your eye and point the tube over your shoulder in the direction of the Sun.*
- *You' ll try to find the Sun's image on the graph paper, looking through the viewing hole. When your pinhole camera is pointed properly at the Sun, you will see a small spot of light on the graph paper. The size of the spot will depend on the length of your pinhole camera*
- *If you have difficulty finding the Sun's image (which will be a small and possibly faint spot of light on the graph paper) there is a trick you can try: Look at the shadow that your pinhole camera tube casts on the ground and move the camera around until its shadow is as small as possible. When the tube is pointed directly at the Sun, its shadow will be at its smallest.*

When you find the Sun's image, attempt to measure its size by counting the number of millimeter lines on the graph paper that it covers, from edge to edge (the image's diameter). Make as careful a measurement as you can.





Seeing Solar Eclipse with Pinhole Camera

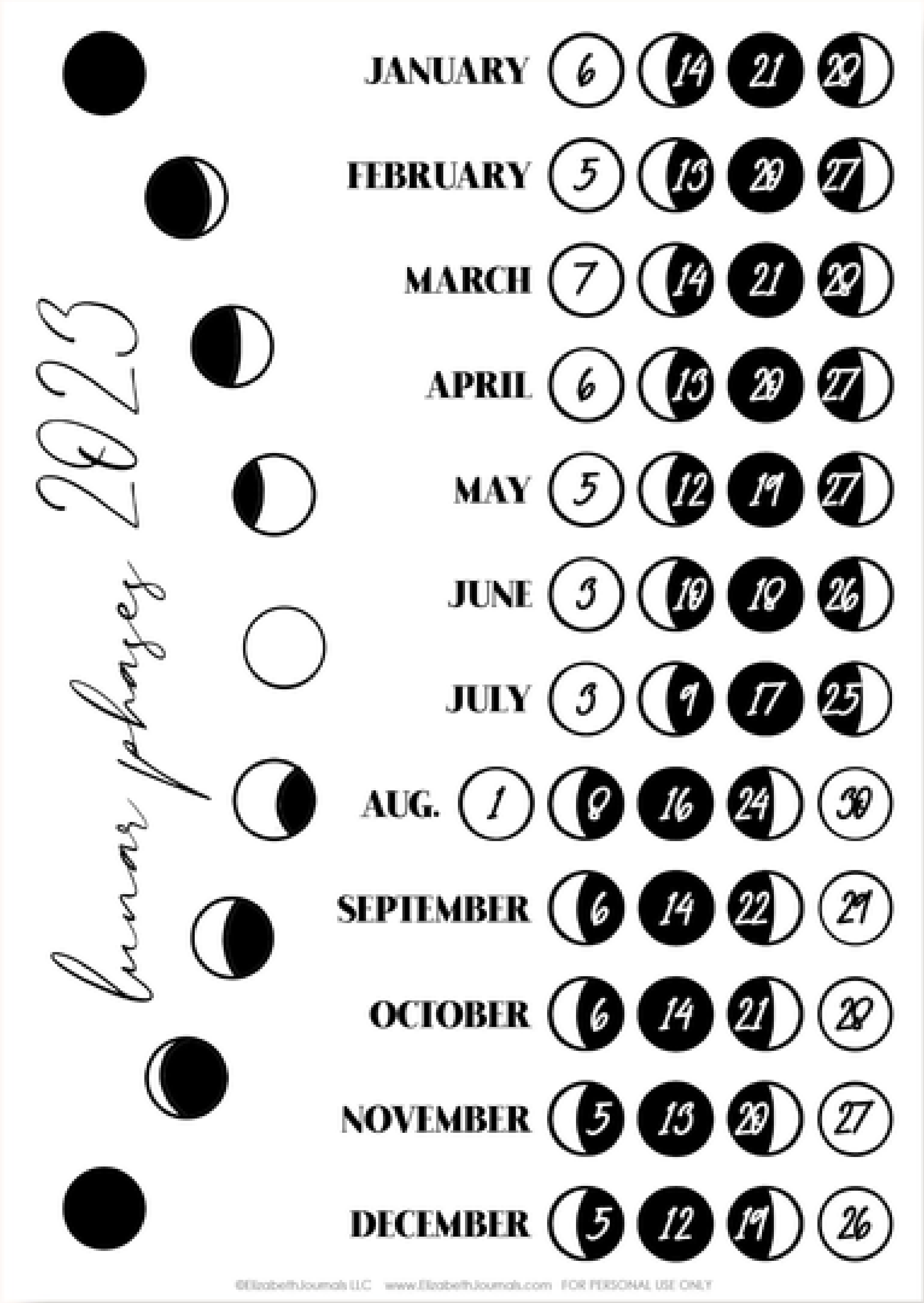
Pinhole projection is a convenient method for safe viewing of the partially eclipsed Sun
With the Sun behind you, pass sunlight through a small opening (for example, a hole punched in an index card) and project a solar image onto a nearby surface (for example, another card, a wall, or the ground).

A pasta colander makes a terrific pinhole projector, as does a straw hat or anything else with a bunch of small holes in it.

With the Sun at your back, you project sunlight through the hole(s) onto a surface and look at the solar image(s) on the surface. Note too that pinhole projection is not useful for observing the total phase of a total solar eclipse; the projected image would be too faint to see.

Preparing Lunar Calender

A lunar calendar is a calendar based on the monthly cycles of the Moon's phases (synodic months, lunations), in contrast to solar calendars, whose annual cycles are based on the solar year.



Materials Needed to Build a Moon Phase Tracker

- *1 Copy of the Moon Phases*
- *1 Scissors*
- *1 Piece of Cardboard, cut into a medium-sized square*
- *Small Metal Brad*
- *Glue*

Building a Moon Phase Tracker

In this activity, firstly we cut out each of the phases of the moon and the pointer on the pages provided and arrange them on a piece of cardboard .Then,we pasted each moon phase in its appropriate position on the cardboard After we attached the pointer in the center of the moon phases with the metal brad, we tracked the moon phases by rotating the pointer counterclockwise to the current lunar stage. Finally, it was ready.

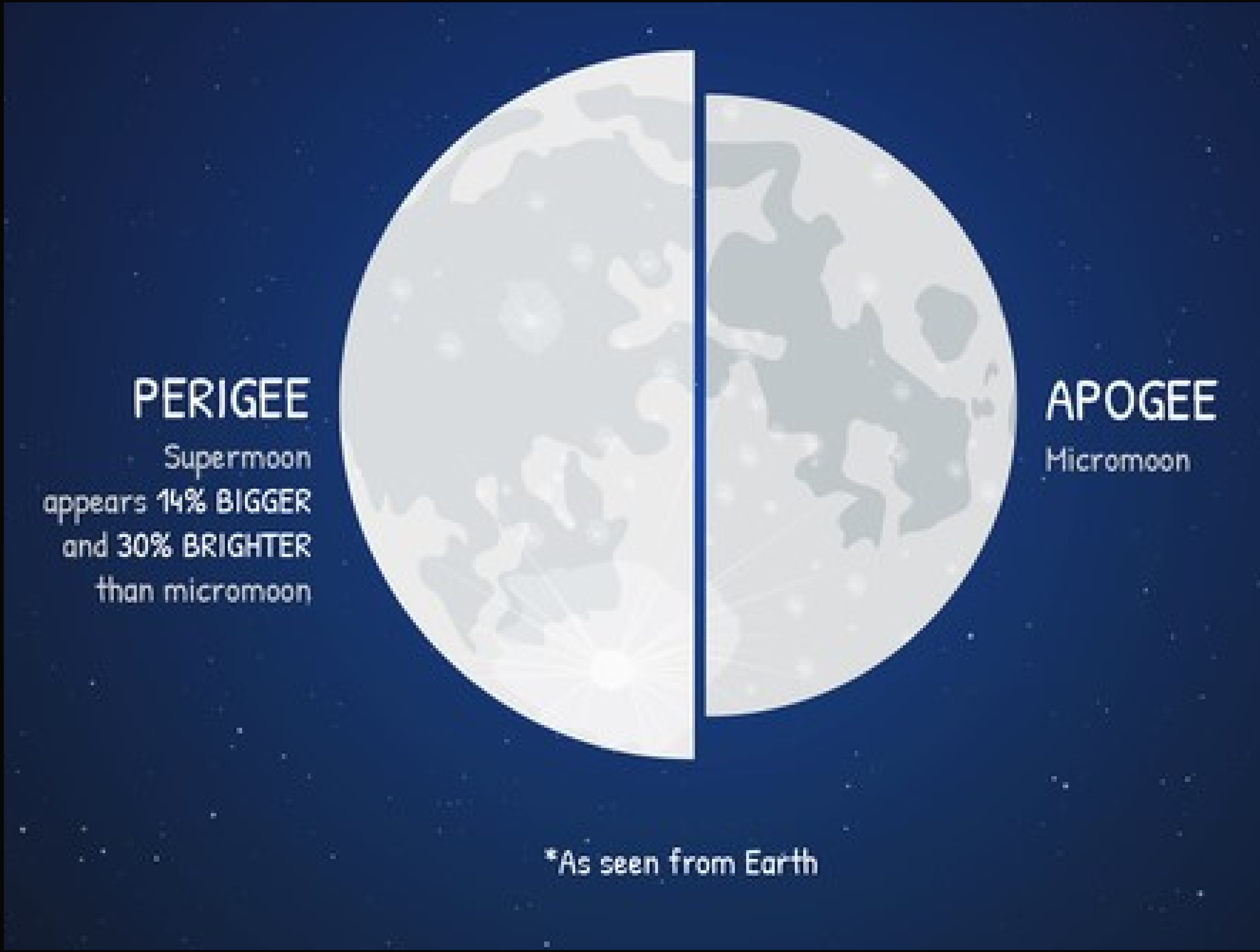
Note: Using a counterclockwise motion mimics the direction the moon.

CalculatIng the RelatIve BrIghtness of the Supermoon

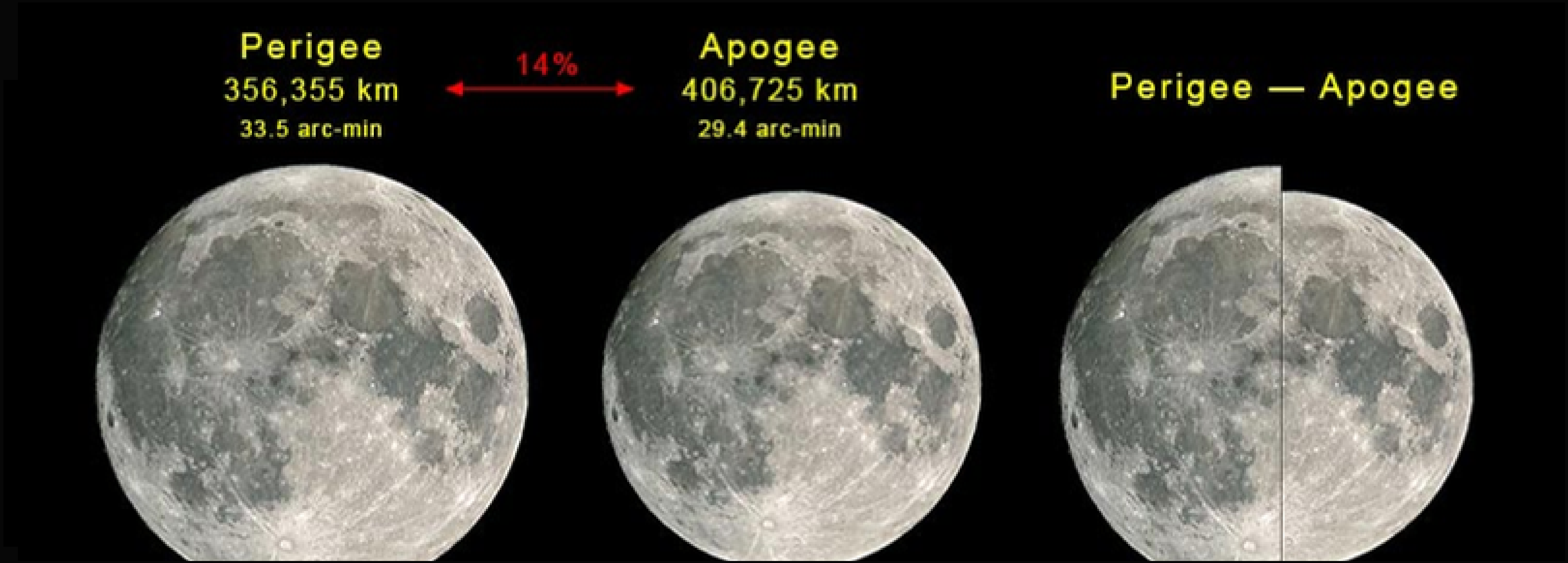
The Moon doesn’t orbit in a perfect circle. Instead, it travels in an ellipse which brings the Moon closer to and farther from Earth in its orbit. The farthest point in this ellipse is called the apogee. Its closest point is the perigee.

During every 27-day orbit around Earth, the Moon reaches both its apogee and perigee. Full moons can occur at any point along the Moon's elliptical path, but when a full moon occurs at or near the perigee, it looks slightly larger and brighter than a typical full moon. That's what the term "supermoon" refers to.

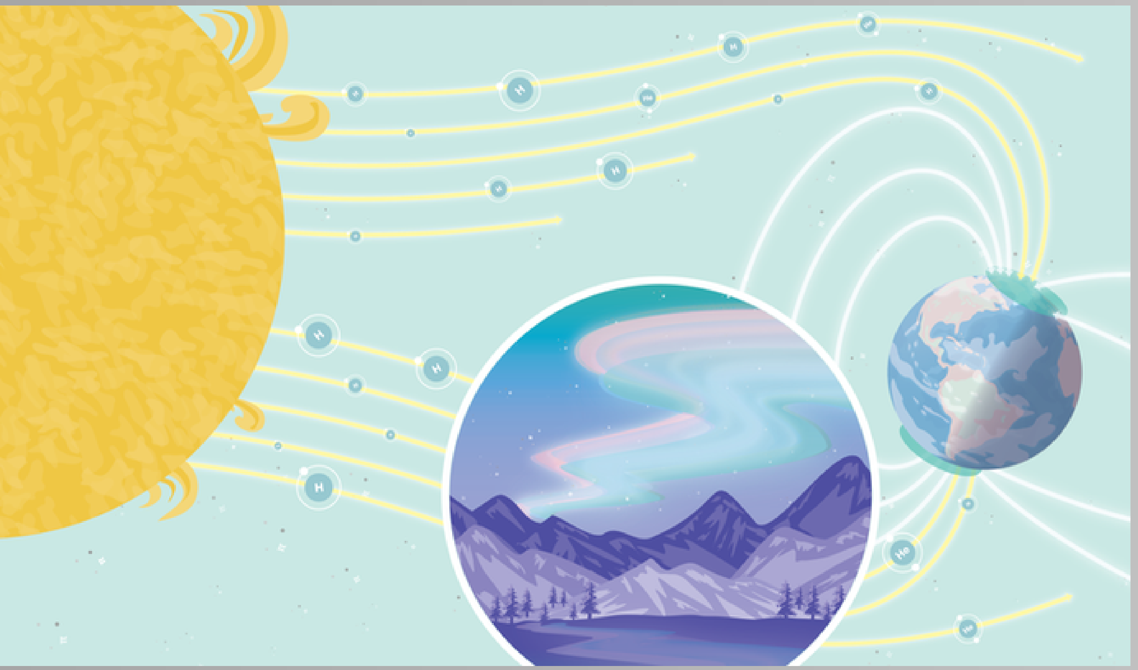
The light from a full moon is bright enough to cast shadows, but it is still very dim. In fact, it's so dim that a mobile device's light sensor combined with a basic lux measurement app won't register a reading. Direct sunlight is about 1 million times brighter! Instead of using a light meter to measure the brightness of the Moon, you can mathematically compare the light intensity (I_1) of a full Moon at apogee (D_1) to the light intensity (I_2) of a full supermoon at perigee (D_2)

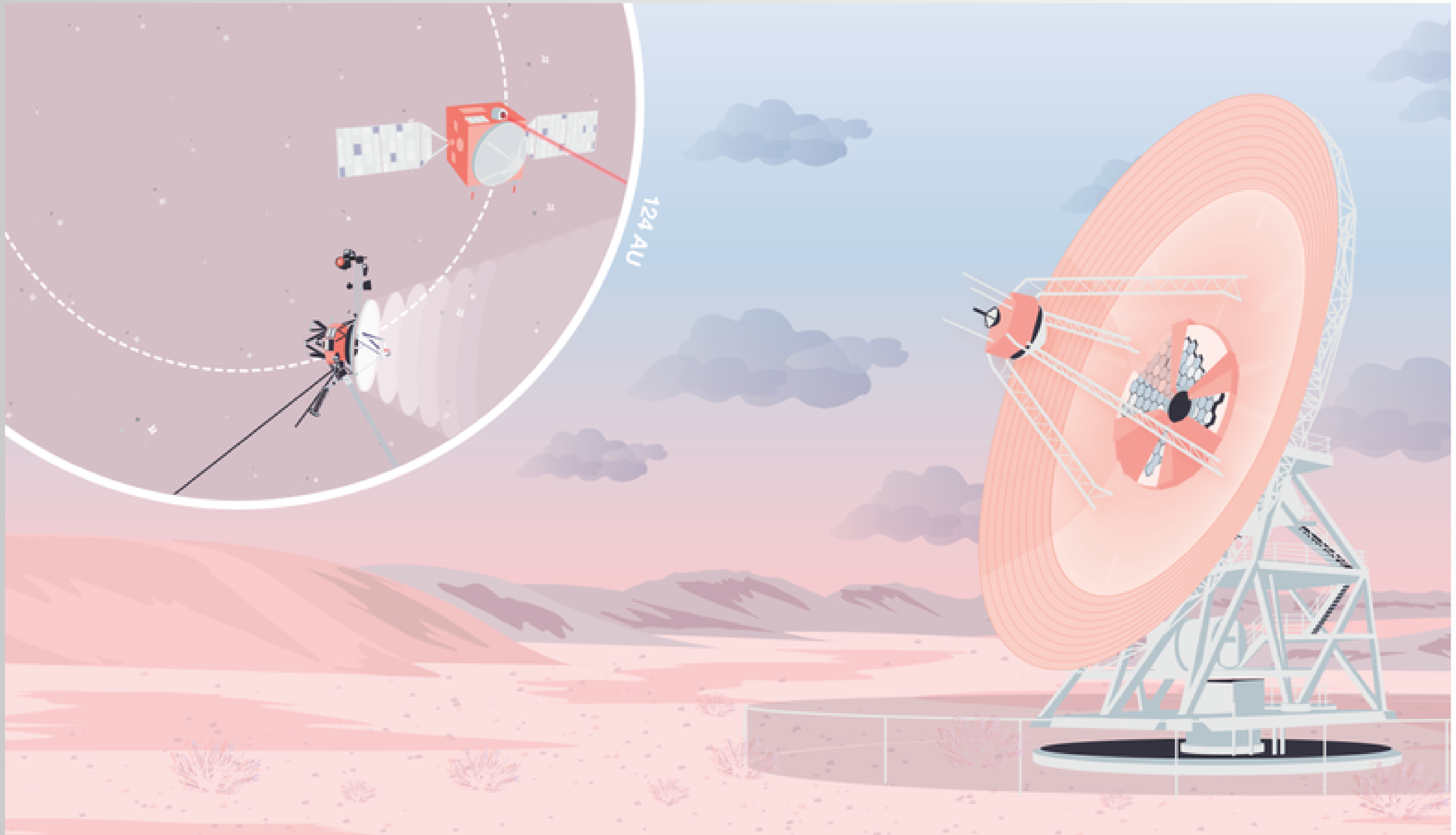


Relative Brightness is composed of two values that express the brightness of the Full Moon relative to its brightness at the current apogee (left) and at its mean distance (right). A supermoon is typically 1.3 times (or 30%) brighter than a Full Moon at apogee, and 1.15 times (or 15%) brighter than a Full Moon at the Moon's mean distance.

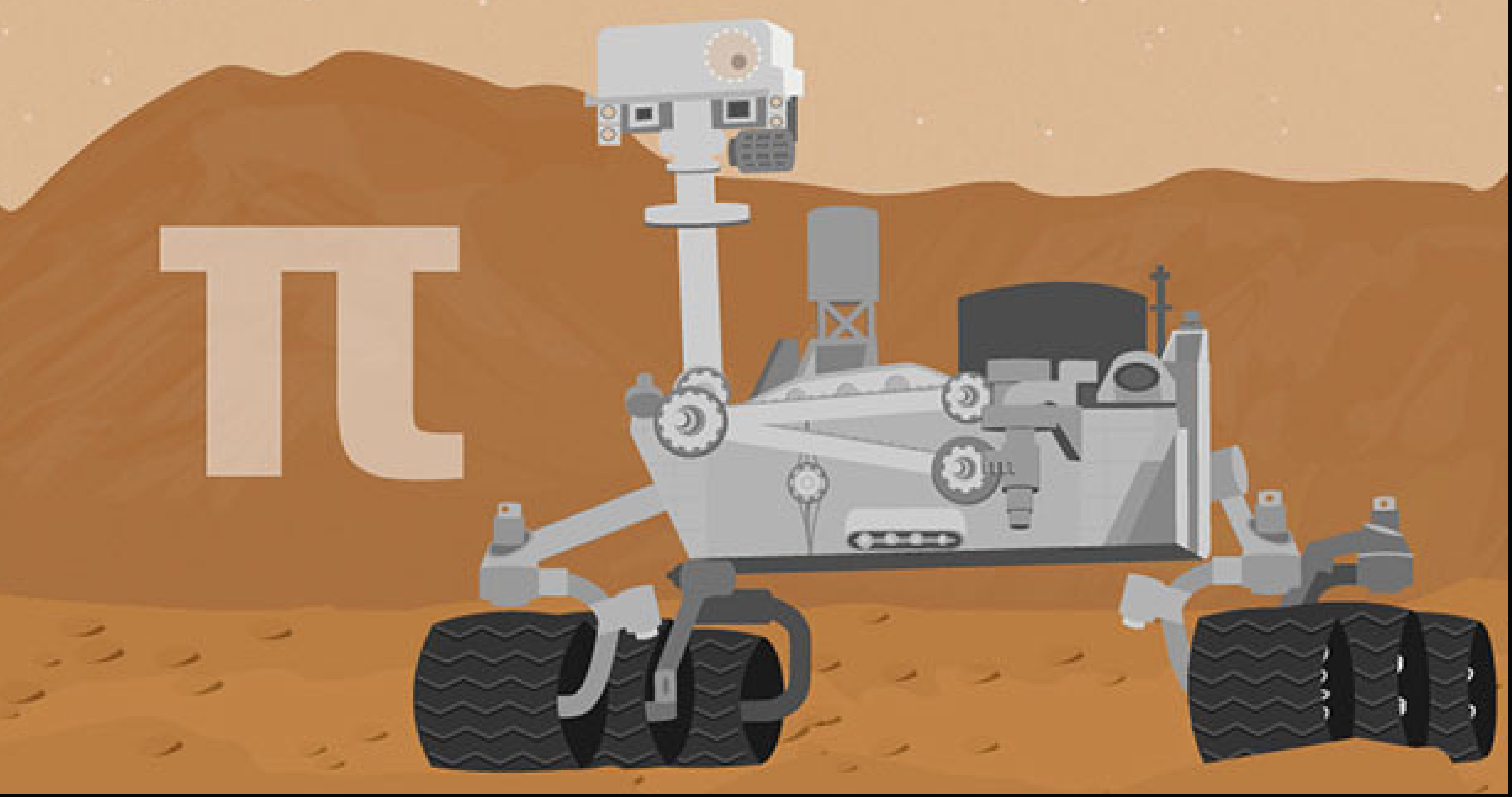


π IN THE SKY

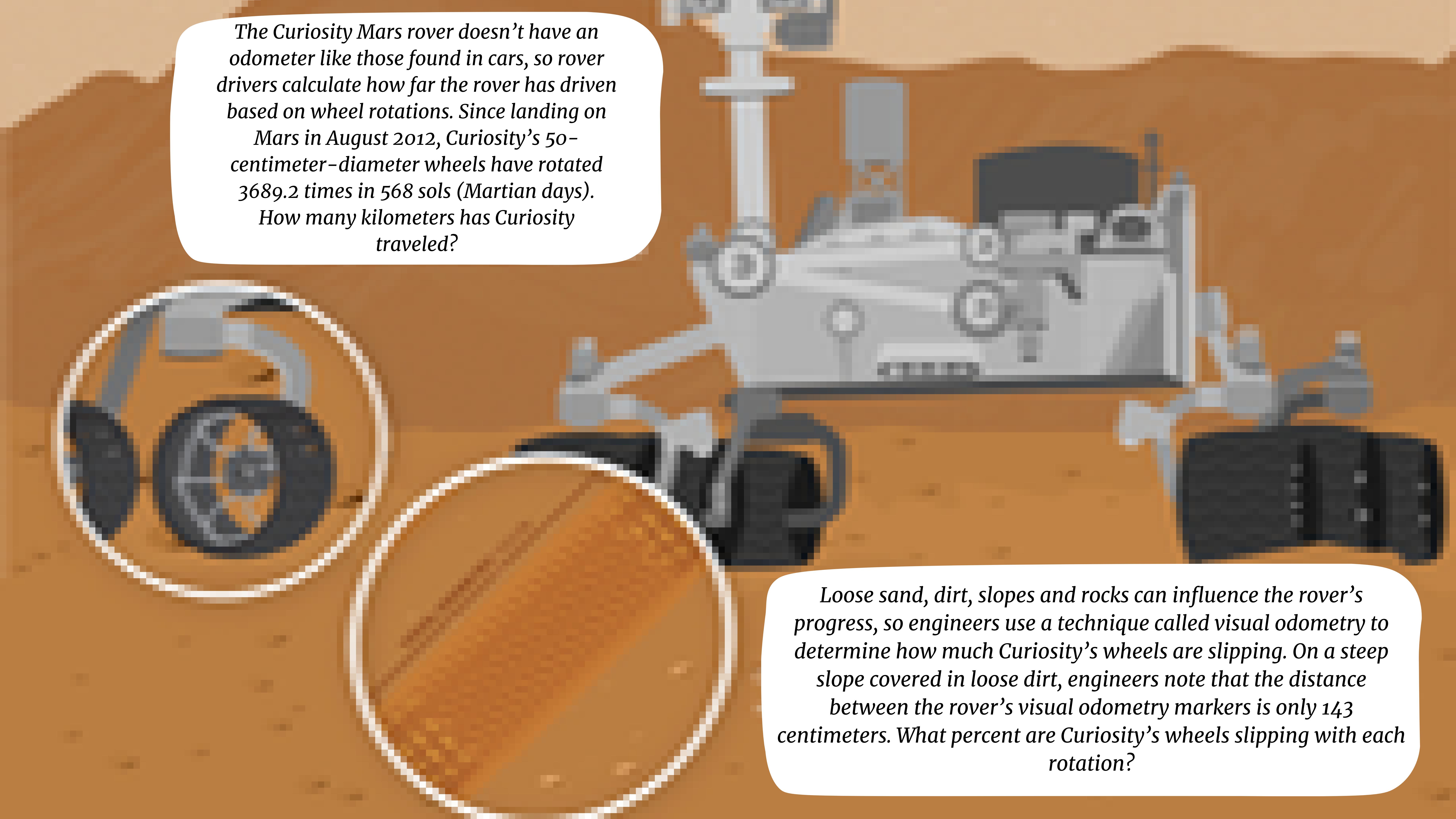




Pi isn't just a fancy number. It actually powers NASA spacecraft, keeps the Mars rover's wheels spinning, lets us peer beneath the clouds of Jupiter and gives us new perspectives on Earth. You might say pi is flying all over our skies.

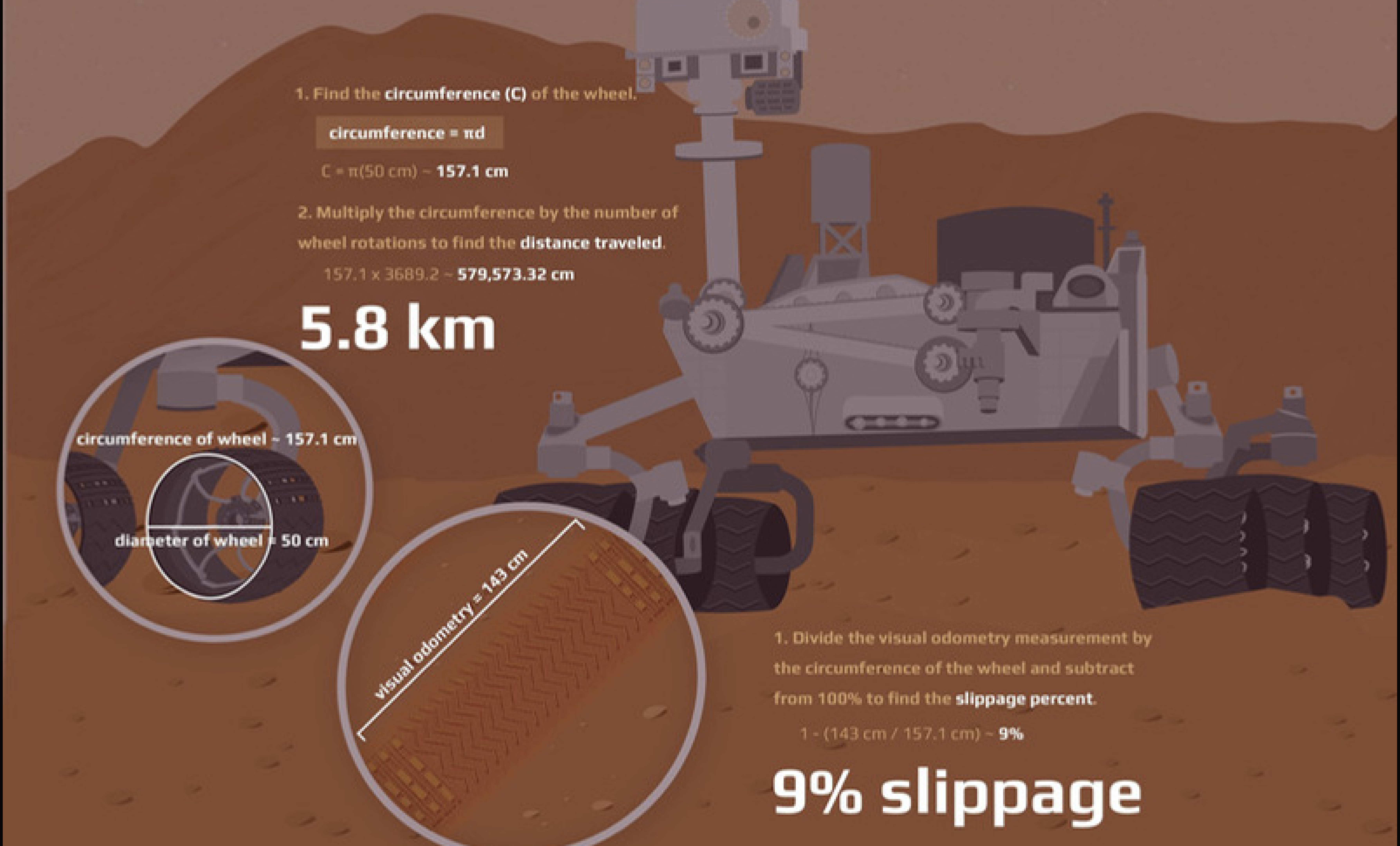


This visual math problem set gives students a chance to put their knowledge of the mathematical constant pi to the test by solving some of the same calculations that NASA scientists and engineers use to explore space.



The Curiosity Mars rover doesn't have an odometer like those found in cars, so rover drivers calculate how far the rover has driven based on wheel rotations. Since landing on Mars in August 2012, Curiosity's 50-centimeter-diameter wheels have rotated 3689.2 times in 568 sols (Martian days). How many kilometers has Curiosity traveled?

Loose sand, dirt, slopes and rocks can influence the rover's progress, so engineers use a technique called visual odometry to determine how much Curiosity's wheels are slipping. On a steep slope covered in loose dirt, engineers note that the distance between the rover's visual odometry markers is only 143 centimeters. What percent are Curiosity's wheels slipping with each rotation?


1. Find the circumference (C) of the wheel.
circumference = πd
C = π(50 cm) ~ 157.1 cm
2. Multiply the circumference by the number of wheel rotations to find the distance traveled.
157.1 x 3689.2 ~ 579,573.32 cm
5.8 km
circumference of wheel ~ 157.1 cm
diameter of wheel = 50 cm
visual odometry = 143 cm
1. Divide the visual odometry measurement by the circumference of the wheel and subtract from 100% to find the slippage percent.
1 - (143 cm / 157.1 cm) ~ 9%
9% slippage

Modeling the Orbits of Planets

In this activity, students explore the relationship between the masses of objects and the orbits they follow. They will make predictions and try to model different orbital scenarios using a gravity well model constructed in class.

Materials

- *Hula hoop, 30” diameter or larger preferred*
- *Spandex OR other stretchable fabric that can be pulled tightly over the hoop*

8-12 binder clips

- *Spheres of various sizes and masses*

Steps of Modeling

- *Firstly, You’ll drape the fabric over the hula hoop and secure with 8-12 evenly spaced binder clips.A larger hoop can be made using lengths of flexible piping such as thin-walled, small-diameter PVC pipe*

- *You should be aware of the tension that builds up when the pipe is bent and be sure the ends are tightly secured when bending it into a hoop.*

- *Then, you should adjust the fabric and clips as needed so that the fabric is taut but has some give when a spherical mass is placed in the middle.*

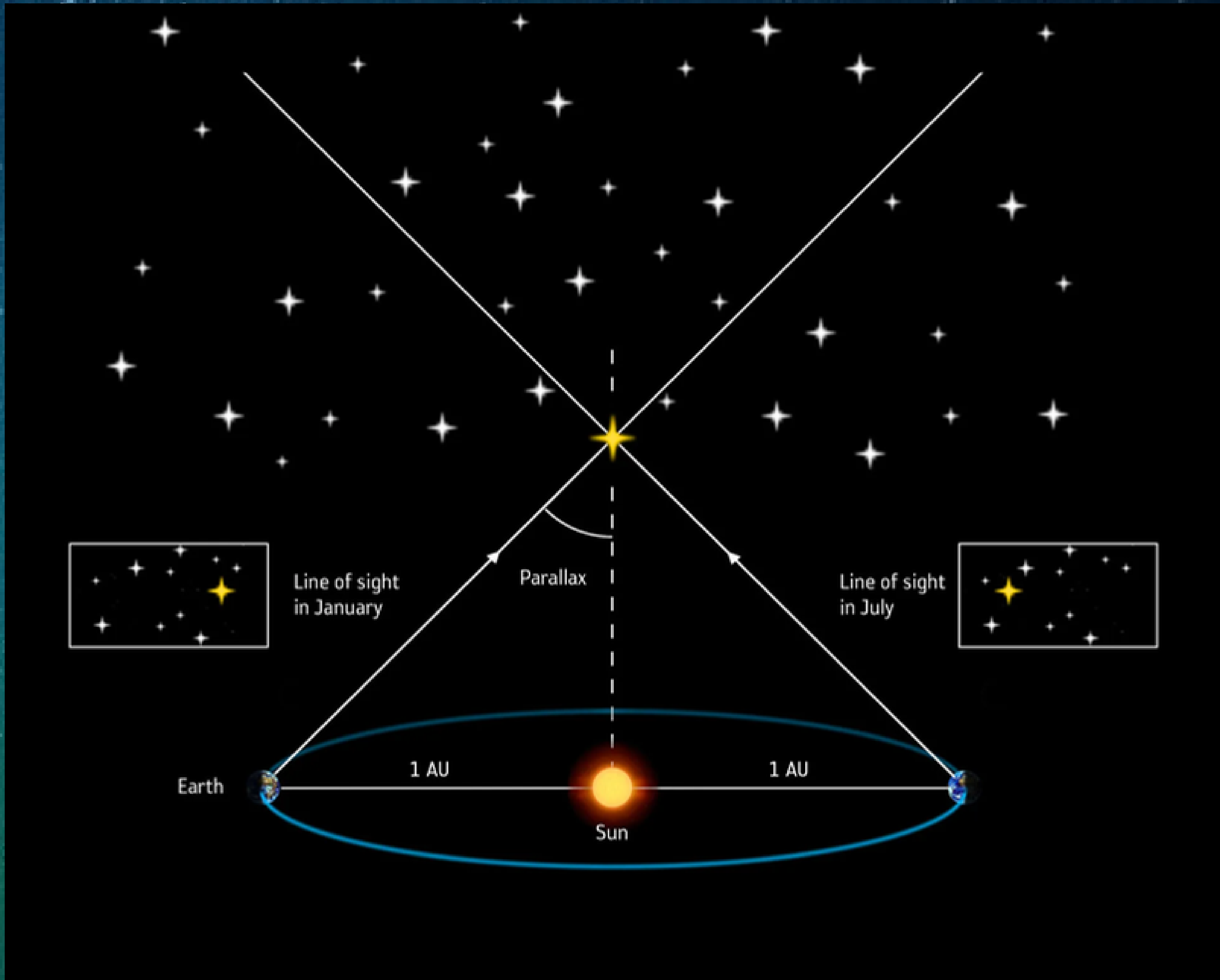
- *After you balance the model on the backs of three to four chairs to provide a stable, level support.,you should consider placing the chairs so the seats face inward and aren't in the way when students gather around the model.*

What is the star clock method?

A star clock (or nocturnal) is a method of using the stars to determine the time. This is accomplished by measuring the Big Dipper's position in the sky based on a standard clock, and then employing simple addition and subtraction. This method requires no tools; others use an astrolabe and a planisphere

How do we measure time by stars?

·If the stars are used, then the interval is called the sidereal day and is defined by the period between two passages of a star (more precisely of the vernal equinox, a reference point on the celestial sphere) across the meridian: it is 23 hours 56 minutes 4.10 seconds of mean solar time.



How do you calculate stellar lifetime?

Stars burn their fuel at a rate set by their luminosity. That rate can be expressed in terms of the mass of fuel burnt per year. If we call M the amount of fuel the star has and R the rate at which it burns its fuel, then the star's life time is just M/R

$$L = L_{\odot}\left(\frac{M}{M_{\odot}}\right)^{3.5}$$

$L_{\odot}$ = luminosity of Sun

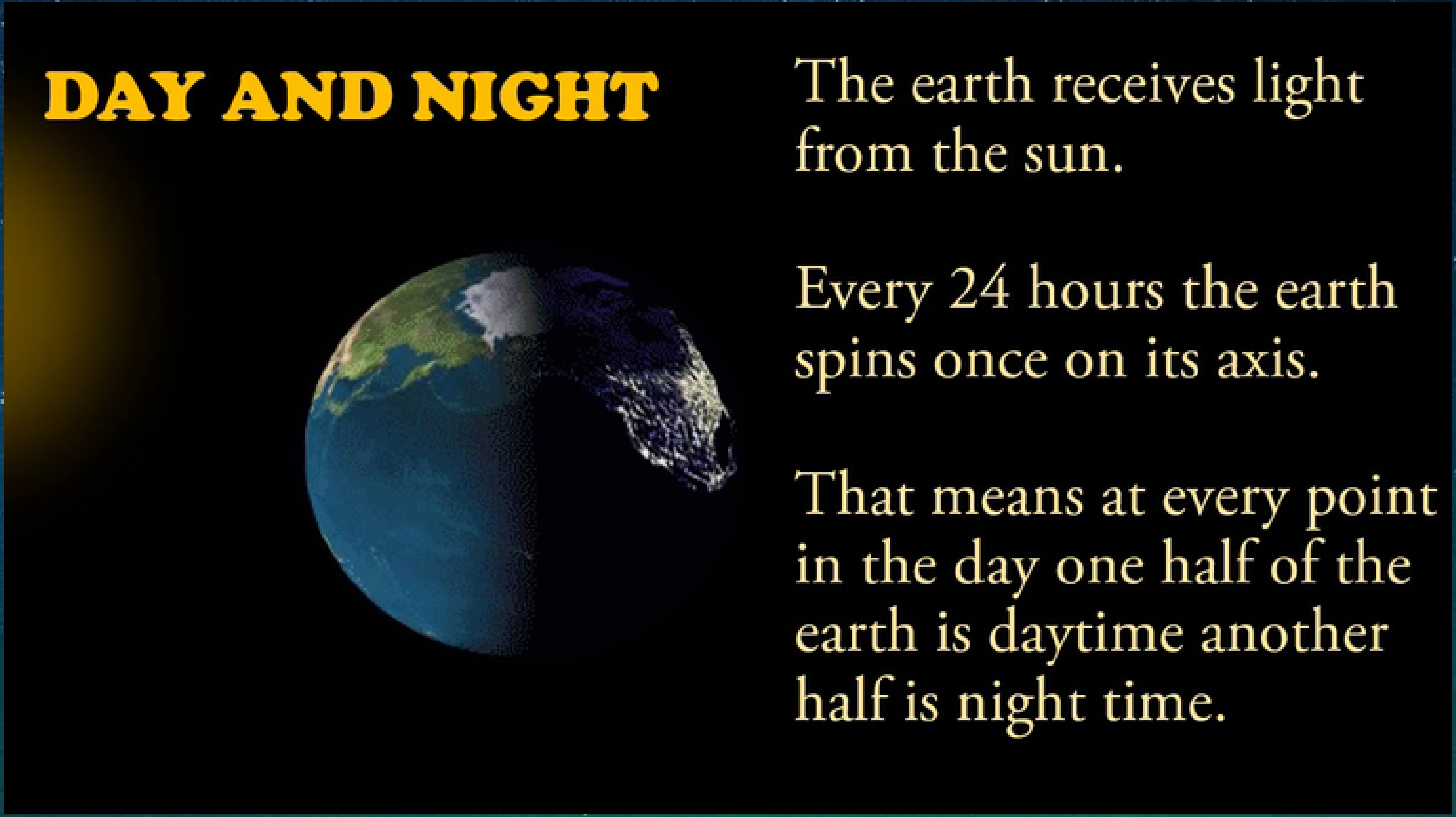
$M_{\odot}$ = mass of Sun

$$Time = \frac{amount\ of\ fuel}{rate\ of\ consumption}$$

or

$$T = \frac{M}{M^{3.5}} = T = \frac{1}{M^{2.5}}$$

How does the day and night happen?



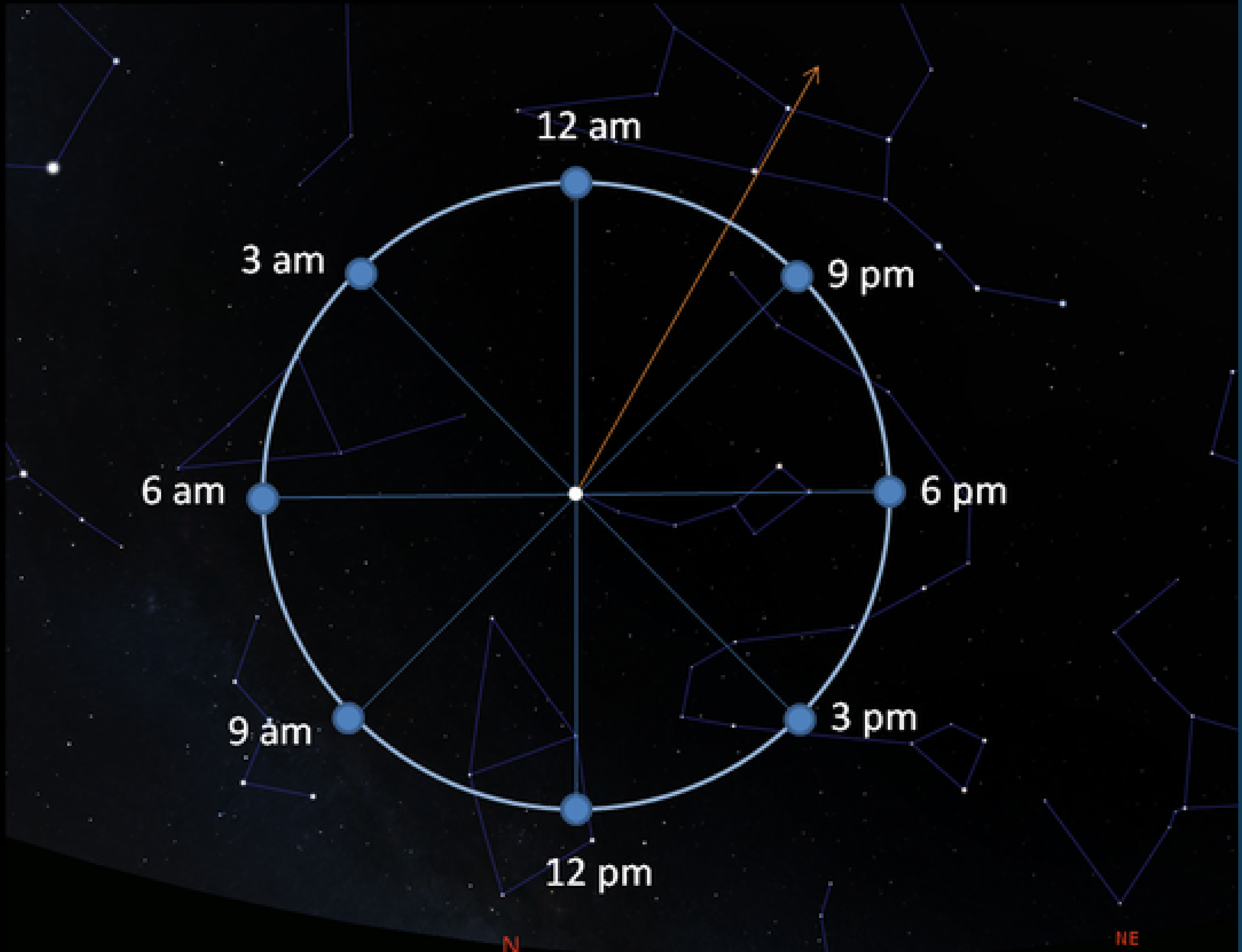
Are the stars moving in the sky?

Stars in the sky appear to be moving because of the rotation of earth on its axis. Earth moves from west to east. Therefore, it appears as if stars are rising in the west and as day dawns they set in the west. So, stars are relatively in motion with respect to the roation of Earth.

Why are stars seen in different locations in the sky?

Earth orbits around the Sun once each year. Our view into space through the night sky changes as we orbit. So, the night sky looks slightly different each night because Earth is in a different spot in its orbit. The stars appear each night to move slightly west of where they were the night before.

How to Tell Time by the Stars!



If you can find the BIG DIPPER, you can find the big clock in the sky! From the northern hemisphere, the big dipper is above the horizon for most of the year. In the spring time (especially in March), it's fun and easy to learn how to tell time by the stars!

How do you find the North Star?

Locating Polaris is easy on any clear night. Just find the Big Dipper. The two stars on the end of the Dipper's "cup" point the way to Polaris, which is the tip of the handle of the Little Dipper, or the tail of the little bear in the constellation Ursa Minor.

Light Pollution and the Stars

Materials

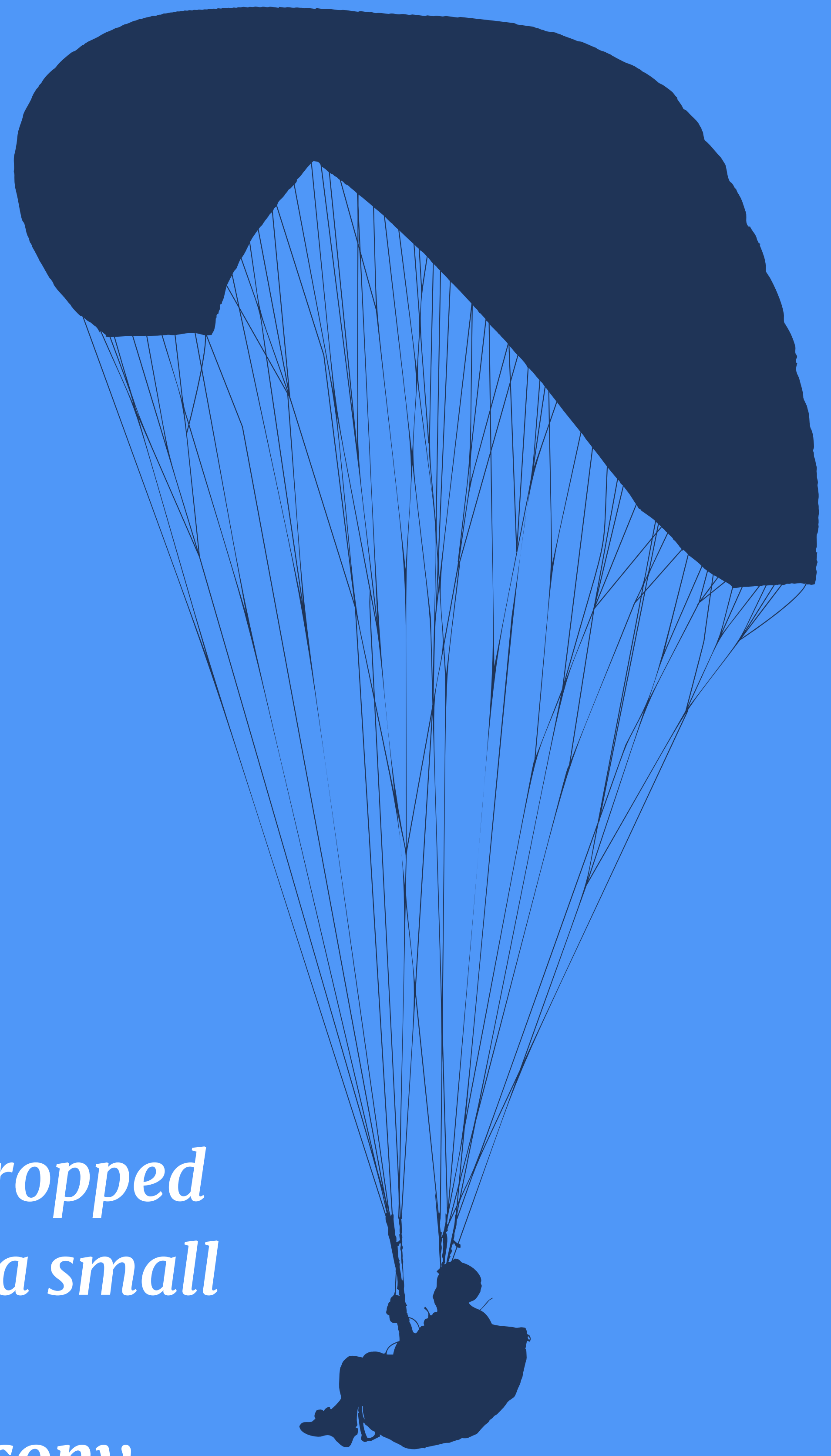
- ·Flashlight
- ·Black construction paper
- ·Scissors
- ·Tape
- ·Sharpened pencil, needle, or pin
- Room where you can control the amount of light, preferably with some variation instead of just on/off

Instructions

First of all,you cut a piece of construction paper slightly larger than the front of your flashlight. Then, you'll poke holes in the construction paper to form a "constellation."
After you tape the piece of construction paper to the front of your flashlight, you'll take your flashlight into a completely dark room. When you turn off all the lights, close the doors and window blinds,you should turn your flashlight on and aim it at the ceiling.
Now, you should try to gradually brighten the room. For example, open a single window blind partway, or turn a dimmer switch up a little bit.Finall, you should aim your flashlight at the ceiling again.

You probably found that you could easily see your homemade constellation in a darkened room. However, as the amount of "light pollution" increased as you turned on other light sources, your constellation would gradually disappear. This is the same problem experienced by astronomers and stargazers. As human civilization as expands and we add more and more artificial lighting, we make it harder to see the stars! This makes it difficult for people to go stargazing, and harder for astronomers to take pictures of stars using telescopes.

Make a Parachute



MATERIALS

- *Tissue paper or a plastic bag*
- *Scissors*
- *Ruler*
- *Tape*
- *Hole puncher*
- *Twine*
- *Small non-breakable action figure or miniature doll that may be dropped on the floor. If you do not have an action figure, use a piece of clay, a small wooden block, a measuring spoon, etc.*
- *Location to drop your parachute from, e.g. a 2nd floor window, balcony, open staircase*

INSTRUCTIONS

Firstly, you ‘ll bring your parachute and action figure to your test location.In a moment, you will drop your figure (without the parachute) from this spot.Then,you drop your figure from the the same location several times to see if your predictions were correct.After that,you attach the parachute to your figure by winding the knotted end of the suspension lines around the middle of your figure and securing it with a knot or tape.

When you fold your canopy in four so its four corners lay on top of each other, you should make sure the suspension lines are not tangled. After you pick the parachute up from the corner diagonally opposite the corner with the strings. You figure should now hang under the parachute.

You ‘ll drop your figure equipped with parachute several more times from the same location.

After you fold your parachute in four so the corners are stacked, you ‘ll cut the tip of the corner that is diagonally opposite the corner with the strings attached.

When you open your parachute you’ll see that there is now a hole in the middle of the canopy.

Now, you fold your canopy in four again. Finally, you pick it up at the corner that has been cut away and drop your figure several times from the same location.

What Happened?

Your figure probably fell straight down and had a hard landing at first. The figure equipped with a parachute probably had a softer landing, but it was probably also harder to predict where exactly it would land. The figure equipped with the parachute with the hole in the middle probably still had a pretty soft landing. All of this is expected.

Gravitational Waves

Gravitational waves are invisible. However, they are incredibly fast. They travel at the speed of light (186,000 miles per second). Gravitational waves squeeze and stretch anything in their path as they pass by.

The most powerful gravitational waves are created when objects move at very high speeds. Some examples of events that could cause a gravitational wave are:

·when a star explodes asymmetrically (called a supernova)

·when two big stars orbit each other

·when two black holes orbit each other and merge

In this activity, Students develop a model to represent the collision of two black holes, the gravitational waves that result and the waves' propagation through spacetime.

Materials

Gelatin (clear or yellow)
- *Baking pan (clear, smooth glass preferred)*
- *Cutting board, cookie sheet or other flat, portable surface*
- *Small mirror*
- *Two small steel marbles, ball bearings or round pebbles*
- *Laser pointer (red or green laser)*
- *Laser Target Card*

Management

The gelatin should be made and set in advance of creating the model.

- *The model can be developed in pairs, small groups, larger groups, or as a whole class demonstration, depending on availability of materials.*
- *The pan provides a lot of structural support for the gelatin. Taking the gelatin out of the pan and inserting a mirror makes the gelatin more susceptible to rough edges and tears that will affect the model. You can avoid this by using a clear pan (without textures in the glass that would affect the path of the laser beam). This way the gelatin can be kept in the pan. In this case, skip steps 2 and 4, and press the marble into the gelatin after the gelatin sets so that it is flush with the surface. This provides more stability to the gelatin and keeps the edges smooth, reducing the amount of scattering that the laser beam experiences.*

Safety Note:

- ***Lasers are a potential hazard because they can burn the retina of the eye. Avoid direct eye exposure and take caution when pointing a laser at a mirror to avoid accidental reflections of a laser beam into anyone's eyes***

Procedures

You 'll prepare the gelatin according to the package directions and pour it in the baking pan. Be sure enough gelatin fills the pan that the mirror will be mostly or completely covered when it's inserted

Then, you 'll place a marble or pebble in one corner of the gelatin, about one inch from the sides of the pan, and allow it to sink to the bottom.

Please , allow the gelatin to completely set.

Once the gelatin is firm, place a flat portable surface (such as a cutting board or a cookie sheet) on top of the pan, You should gently flip the pan and remove the gelatin from the pan.

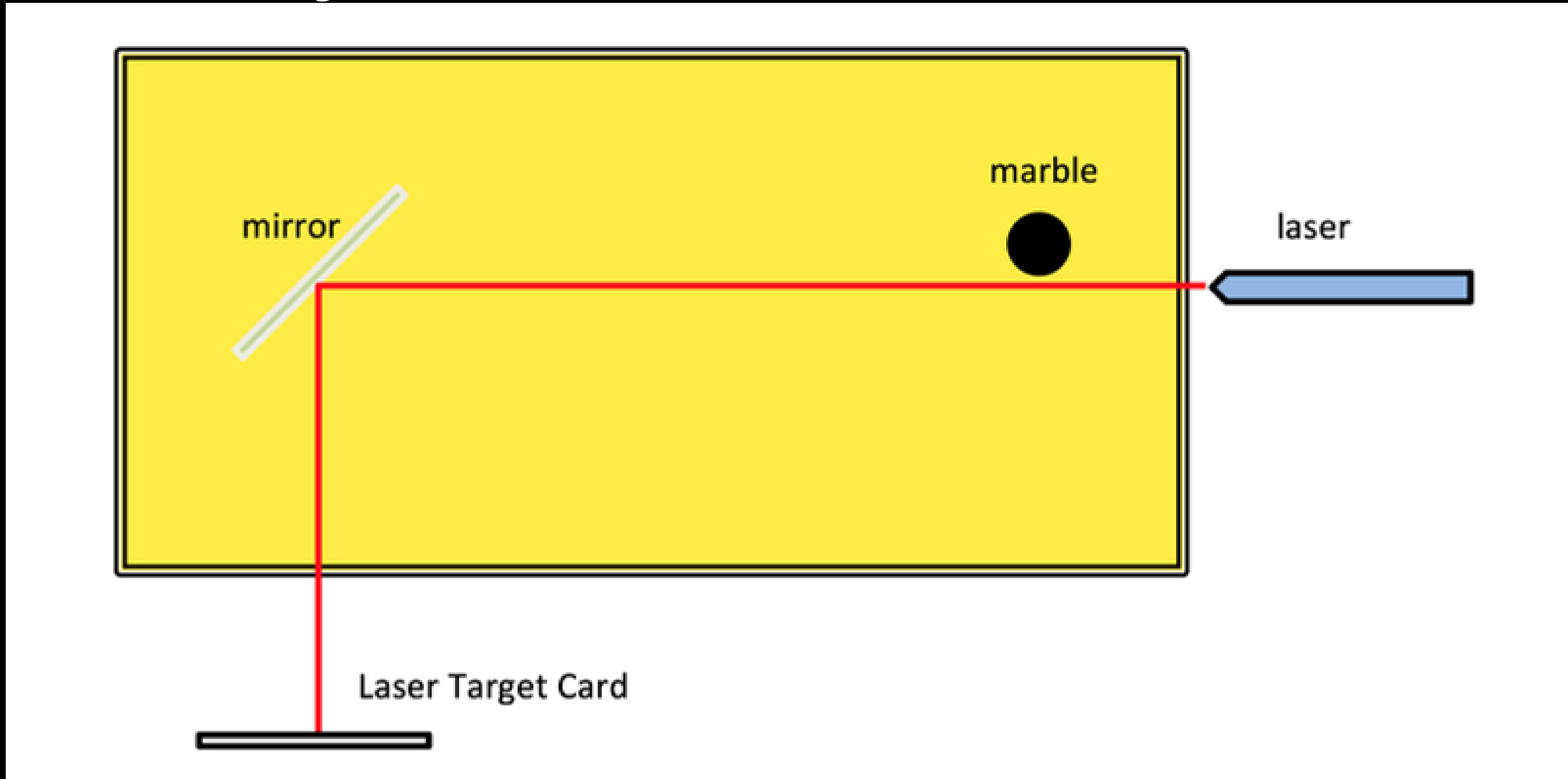
After you press the mirror into the gelatin at a 45-degree angle opposite the marble,you should be sure to put the mirror far enough away from the edges of the gelatin that the gelatin stays intact

Pointing through the gelatin from the side closest to the marble, you'll aim the laser at the mirror and secure it so it doesn't move (e.g., by taping it to a book or binder)At taht time, please use tape or a binder clip to hold down the laser's on-button.

When you place the Laser Target Card outside the gelatin in the path of the reflected laser,you should secure it so the card is stationary.

With the laser and Laser Target Card steady, you'll drop a second marble on the marble that is set in the gelatin.

In this model, the gelatin represents spacetime. The collision of the marbles or pebbles represents the collision of two black holes. The vibrations in the gelatin represent the gravitational waves, and the movement of the laser on the marker card indicates the presence of gravitational waves.



Making Solar Eclipse Glasses with Filter

MATERIALS

- *·A large piece of poster board or card stock.*
- *·A template for your glasses (draw an outline or print out a template).*
- *·A solar filter.*
- *·A roll of blue painter's tape.*
- *·Scissors.*
- *·A pen.*

INSTRUCTIONS

You should verify the Safety of Your Solar Filter Before Use

- *You ‘ll prep Your Frames*

(start by laying out poster board or card stock o)n a flat surface. Next, draw your outline or place your printed template on top. Once your paper is prepped, use your scissors to cut out the frames)

Then, you should insert Your Solar Filter Lenses

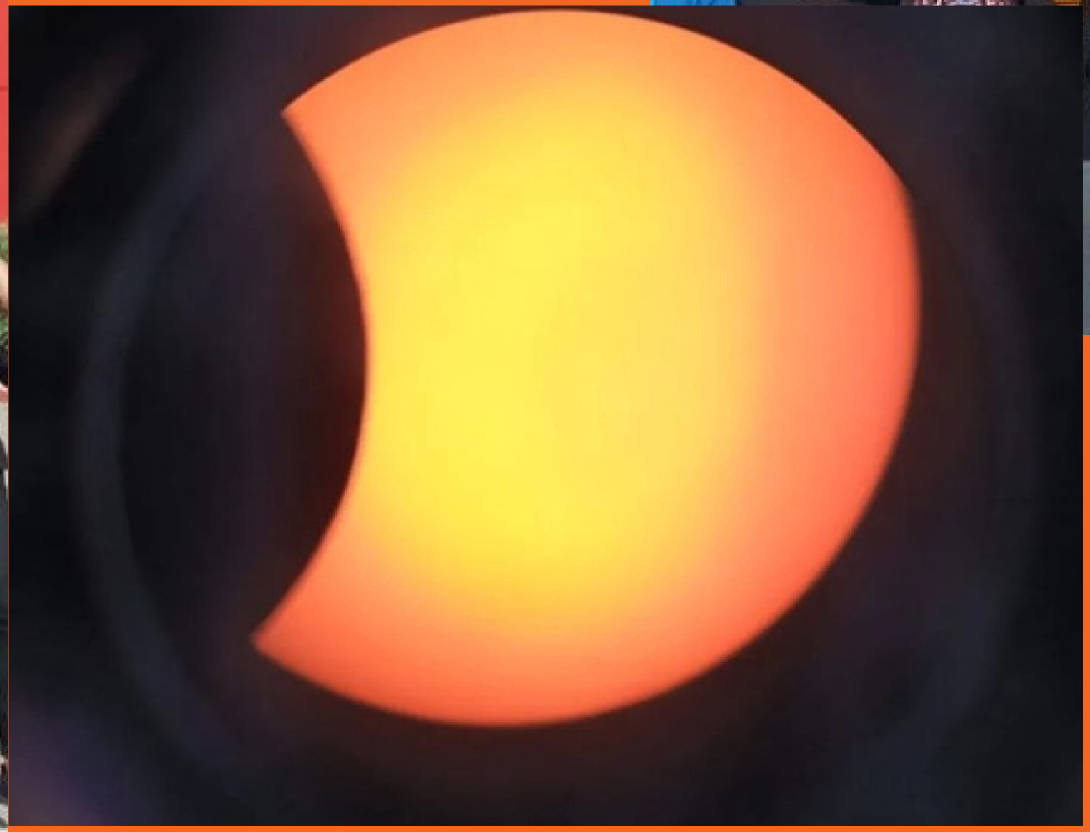
And now, you should secure With Tape

(Once your solar film is in place, secure it to your frames of choice with your roll of blue painter’s tape. If you’re making your solar eclipse glasses out of poster board or card stock, it’s time to tape the earpieces in place as well.)

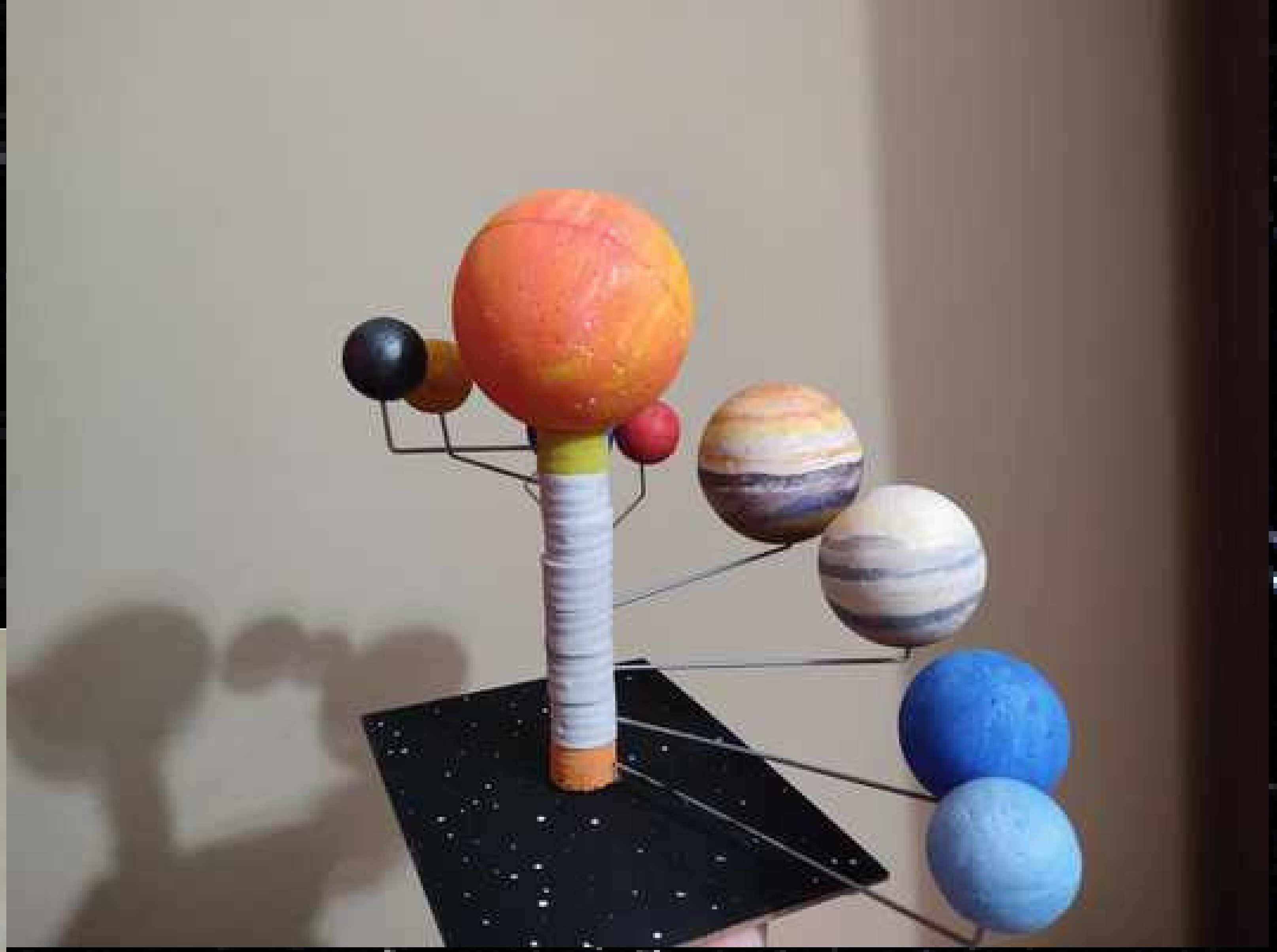
You‘ll go for a Test Run

(it’s time for a test run! Go into a dark room, put the glasses on, and have a friend shine a flashlight in your direction. If any of the bright light comes through (without the yellow/orange hue), you have a leak.)

THE STUDIES OF THE STUDENTS





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REFERENCES

https://www.jpl.nasa.gov/edu/teach/activity/measuring-the-supermoon/

https://www.jpl.nasa.gov/edu/teach/activity/pi-in-the-sky/

https://www.jpl.nasa.gov/edu/teach/activity/modeling-the-orbits-of-planets/

https://bilimgenc.tubitak.gov.tr/makale/yildiz-saati-yapalim

https://www.sciencebuddies.org/stem-activities/constellations-light-pollution

https://www.sciencebuddies.org/stem-activities/parachutes

https://www.jpl.nasa.gov/edu/teach/activity/dropping-in-with-gravitational-waves/